REMARKS

Applicant respectfully requests reconsideration of the rejection of claims 1, 3, 5-9, 11-13, and 15 as amended without the addition of new matter. Claims 2, 4, 10 and 14 have been cancelled. Claims 16-19 are withheld from consideration at the present time. The claims have been amended without new matter for clarity and to emphasize the distinctions from the Wong et al patent, the sole reference cited. Claim 7 was indicated to be allowable but was objected to as dependent from a rejected claim. The Office action reaffirms the Restriction Requirement as to claims 16-19, which are no longer under consideration.

Applicant's invention is a modular cascade refrigeration system capable of providing temperature control of a load over a wide range (e.g. –40°C to +60°C) of selectable temperatures. The sole reference, Wong et al, No. 6,494,054, teaches the use of two refrigeration loops in simple cascade fashion. Although the expansion devices could presumably be varied somewhat (the applications mentioned appear to be static, essentially fixed temperature installations) there is certainly no mention of how to achieve a wide range of controlled temperatures. Specifically Wong et al disclose a main refrigeration loop, in which a "multi-component refrigerant" is cooled <u>after</u> condensation by a chilled and expanded ammonia refrigerant in an auxiliary refrigeration loop. Wong et al discuss only possible variants in choice of in the refrigerants (see column 3, lines 63-67, to column 4, lines 1-22, and column 4, lines 26-35), but nowhere suggest using a fundamental difference in boiling point properties as in parent claims 1 and 11. Furthermore, Wong et al teach only the usage of their system for static temperature control, such as a food freezer (column 4, lines 59-65). Even though other potential uses, such as "reactors for the chemical process industry", etc. are discussed in very general terms, as at column 4, lines 65-67 through column 5, lines 1-2, it is clear that Wong et al neither show nor suggest anything as to how to use cascaded refrigeration loops

with refrigerants of distinctly different boiling points so as to provide, by cumulative interactive chilling, selectable refrigeration levels within a wide temperature range.

Such a range of operating parameters was set out in original claim 1, and is based upon employing, as set out in claim 1 as amended, employing refrigeration loops using refrigerants which have distinctly different liquefaction temperatures and pressures. The Office action dismisses this feature as "obvious" without reliance on any prior art teaching. It is evident, to the contrary, that when two refrigerants differ widely in boiling point levels, they also have characteristics which vary the temperatures and pressures under which they are maintained in the thermodynamic compression, condensation and expansion cycles. For this reason, as is evident in the present specification and the claims as amended, two stages in accordance with the present invention are configured to interchange thermal energy between two stages so as to enable low, selectable, temperature levels to be attained at a process tool without requiring a very large refrigeration unit or high power consumption.

The refrigerant in the upper stage is liquid at ambient pressure and temperature and thus capable of refrigerating through one temperature range. The refrigerant in the lower stage is a gas at ambient temperature and pressure, and thus can, if effectively compressed, refrigerate to a much lower temperature range after expansion. The method of amended claim 1 includes the steps of providing heat extraction from the compressed second refrigerant during condensing of the first refrigerant, and then also effecting thermal energy transfer between the first chilled refrigerant and the second compressed refrigerant to achieve condensation at the lower liquefaction temperature of the second refrigerant. Neither of these two steps is taught by Wong et al, which simply transfers thermal energy <u>once</u> between the expanded ammonia refrigerant and the already condensed multicomponent refrigerant.

Wong et al also do not suggest using controlled expansion of the two different pressurized refrigerants variably to control a temperature, as for a process tool. Thus no reasonable argument that can be made that applicant's teaching of the usage of the stages of extraction of thermal energy from a second refrigerant, before and during condensation is in any way "obvious".

Parent claim 1 to the method, as amended, utilizes expressions originally contained in claims 2 and 4, now cancelled, to make clear the distinctions over the prior art. It thus specifies that the first chilled refrigerant has a first boiling point such that it is liquid at ambient temperature and pressure and that the second refrigerant has a second boiling point lower than the first such that it is a gas at ambient temperature and pressure. These aspects establish a context which is wholly without precedent in the Wong et al case, and the novel need for cumulative modes for liquefying the high boiling point second refrigerant.

Claim 1 as amended also recites more clearly the two different thermal energy transfers between the two refrigeration stages previously set out in claims 2, 4, 5 and 6, and involve no new matter.

Claim 1 as amended also specifies that both the first and second refrigerants are used in conjunction with compressing, condensing and expansion steps, wherein the step of condensing the second refrigerant comprises using heat extraction from the first refrigerant both from the condensation step and from chilling after by selective expansion to a liquid/vapor phase. In Wong et al, the auxiliary refrigerant is merely expanded and heat is exchanged with the main refrigerant, <u>after</u> it is condensed, so that there is no suggestion of how to liquefy a compressed refrigerant having a high boiling point.

Claim 1, therefore, patentably distinguishes over Wong et al in setting out a difference in boiling points of the first and second refrigerants, the uses of different refrigeration energy rates

between the first and second chilled refrigerants, the thermal energy transfers in two modes between the first refrigerant and the second refrigerant.

Claim 3, independent from claim 1 distinguishes for the same reason and also by including the "step of heating the thermal transfer fluid independently to provide fluid temperatures at and above ambient after effecting thermal energy transfer between the first and second refrigerants". There is no suggestion of this step, taken separately or in combination in Wong et al.

Claim 5, now dependent from claim 1, distinguishes from the art cited for the same reason as parent claim 1 and also in specifying the step wherein "condensing the second refrigerant includes in part passing the compressed second refrigerant in heat exchange with the first cooling medium prior to the second thermal energy transfer.

Claims 6, 8, and 9 are all dependent from claim 5 and distinguish for the same reason and the additional steps which they contain. Claim 7 has been indicated to be allowable in its present form, dependent from claim 6.

System claims 13 and 15 were also rejected without specifying how the teachings of the cited reference relate to the claimed combination – the action merely asserts that the recited temperature ranges and boiling point differentials are obvious or matters of "obvious choice". This contention is traversed, as is the statement that one or ordinary skill would be able to "achieve the recited temperature range without undue experimentation". Parent claim 11 has been amended to incorporate the subject matter of claim 14, now cancelled. As amended, claim 11 specifies both the thermal energy interchange loops discussed above, in terms of supply and return conduits extending from the first expansion device in the first module to the condenser/heat exchanger in the second module, and the second module comprising a shunt loop from the second compressor to adjacent the condenser for thermal energy interchange with the first module. These distinguish patentably over

Wong et al by setting out the thermal transfer modes discussed above relative to the method claims.

Claim 12 is dependent from claim 11 as amended and sets forth added patentable details as to the modules, including an air circulating device, and a conductive conduit section disposed in the path of air from the air circulating device. Such features have no counterpart in Wong et al and the features are not discussed in the Office action. In claim 13, dependent from claim 12, the conductive conduit section is defined as comprising finned tubing in the path of air convected by the fan. Claim 15 is dependent from claim 11 and includes the feature of using a water-cooled condenser in the first module, together with an air blower interacting with the heat exchange path in the second module. Again there is no counterpart in Wong et al and no suggestion of some in the Office action.

In the light of the above considerations, claims 1, 3, 5-9, 11-13 and 15 are resubmitted as amended.

Respectfully submitted,

Kenneth W. Cowans
Applicant

Raymond A. Bogucki
Attorney for Applicant

By: Douglas R. Hanscom
Reg. No. 26,600

Jones, Tullar & Cooper, P.C.
P.O. Box 2266
EADS Station
Arlington, VA 22202
(703) 415-1500